TUBERCULOSIS.

(*a*) Cause. (*b*) Mode of Infection. (*c*) Prevention. (1) By the Individual. (2) By the State.

(Read August 10th, 1896.)

By Gregory Sprott, M.D., D.P.H., Health Officer for the City of Hobart.

"In matters of prevention knowledge is power."—Dr. Burdon Sanderson, *Harveran oration.*

The subject I propose to deal with to-night is one of interest, not only to the medical and veterinary professions, but to every member of the community. Tuberculosis is one of the most widespread diseases we have to deal with, and causes more suffering to humanity than any other known disease at the present time. Its ravages are only equalled by those of small pox in the last century.

Preventive medicine has of late years done much towards the diminution of what we generally look upon as the infectious diseases, but has it been employed against the spread of tuberculosis in the same meritorious way? I am bound to tell you it has not, and yet there is no disease that the science of State medicine could be more profitably employed against than that of tuberculosis. It is indeed appalling to see so many of our young men and women cut off in the prime of man or womanhood. The choicest specimens of our race are frequently the first to go, and those who are not doomed to a speedy death are frequently chronic invalids, incapacitated for work.

No apology is therefore necessary for bringing before you a subject which is not only important to the individual, but to the whole of the nations which are so heavily burdened by it.

Tuberculosis is a specific infectious disease caused by the bacillus tuberculosis of Koch. It is common to man and the lower animals. In the human subject it appears in different forms—such as phthisis pulmonalis, tabes mesenteric, tubercular meningitis, scrofula, lupus, etc., but these are all causally related to the bacillus of Koch.

In the lower animals it is common to rabbits, guinea pigs, monkeys, fowls, etc. In the bovines it is known as "Perlsucht," or "Grapes."

Dr. Crisp stated he had met with it in more than one hundred species of animals, including quadrupeds, birds, and reptiles. Neither the goat nor the donkey are very subject

to it, and in the case of the donkey it is mostly recoverable. It has recently been artificially produced in fish. It may be said to be the most widespread disease we have in domesticated animals, though somewhat rare in their wild state.

There is no longer any doubt about the bacteriological identity of all these forms of tuberculosis in the different animals. It was at one time thought that the bacillus in tubercular fowls differed from that found in animals, but it is now generally believed that any slight difference that may exist can be accounted for by the different soil on which the bacillus is reared.

Wherever man goes we find tuberculosis, and where human beings are most crowded together, there the mortality is highest. No country is free from it, but the Faroe Islands, Iceland, Hebrides of Scotland, and the Highlands of Switzerland enjoy a marked relative immunity.

In many parts of the vast space of Africa, as in the Upper part of the Nile, it is almost unknown. In Algeria the free Arabs are not affected, while those in captivity readily contract the disease. It is prevalent in those who live in the heat of India or Australasia, as well as amongst those who are subjected to the colds of Canada and many parts of America, where it is said to be on the increase.

It is not therefore confined to any particular country, but, speaking generally, it is most prevalent in countries within the temperate zone, and especially amongst the most densely populated parts of these countries.

With its distribution climate would seem to have very little to do, but some observers hold it is more severe and rapid in tropical (India, China, and Japan) than in temperate regions.

All are agreed, however, that a moist, damp atmosphere is decidedly favourable to its prevalence. How this acts is not yet determined. It may have a direct action on the life history of the bacillus, or an indirect action by a relaxing effect upon the mucous membranes.

Certain seasons of the year have some influence over the prevalence. In Britain the maximum of phthisis is in March, April, and May, with a minimum in August, September, and October. The maximum of tabes mesenteric is, however, in July and August. It has a distinct relationship to the temperature, being most prevalent during the diarrhœa season. The minimum is in December, January, and February.

In Australasia the maximum occurs at different seasons in the various colonies.

No race of people are exempt, but the Jews seem to enjoy a comparative immunity.

Many of the races, such as the negroes, on changing their primitive mode of life and migrating to temperate climes, are peculiarly susceptible to the tubercular virus.

A very large percentage of the Maoris die of consumption, and in Queensland the death rate of phthisis is much swollen by the Kanakas.

Females are said to be more subject to tuberculosis than males, but this varies slightly in different colonies and countries, Tuberculosis is common among infants, and it is estimated that one-fourth of all children dying die of abdominal consumption.

Phthisis pulmonalis is commonest between the ages of 25 to 30 years. Ransome estimated that one-half of all deaths at marriageable ages are due to phthisis.

In 1891 one male died out of every 913 persons living, and one female out of every 1,190 in the Australasian group, excluding Western Australia.

I need not enter into the statistical part of this subject. Let me tell you it is the greatest single cause of death in the United Kingdom as well as in Australasia.

In England alone 70,000 deaths occur on an average every year, 50,000 of these being due to consumption of lungs; while the other 20,000 from other forms of tuberculosis.

In Australasia, for the three years 1890, 1891, and 1892, the total number of deaths from phthisis alone was 12,243, out of a total number of deaths of 153,069, being about 8 per cent. of all causes.

The following table * shows the death rate from phthisis per 100 deaths from all causes from years 1890, 1891, and 1892:—England, 11; Queensland, 8·9; Victoria, 8·9; New Zealand, 8·1; South Australia, 7·8: New South Wales, 6·9; Tasmania, 6·2; Western Australia, 5·9.

If we take the death rate per 100,000 persons living, and this is the more accurate method, for the same period as above the order is slightly different.

Deaths from phthisis per 100,000 persons living:—England, 164; Victoria, 136; Queensland, 116; South Australia, 97; Western Australia, 96; New South Wales, 90; Tasmania, 90; New Zealand, 81.

With the exception of New Zealand, our own colony has the best record.

If to the 4,081 that die annually from phthisis we add the number of deaths from other forms of tubercular diseases, we will have a total of at least of 6,000 lives lost to these colonies every year.

*See Dr. Mullin's paper in the *Australian Medical Gazette*, August 20, 1895.

You can readily see what an enormous saving of life it would be to the colonies, as well as to Britain, if we could only prevent this disease in its many forms.

When we consider the prevalence of this disease in man and animals, is it to be wondered at that so many have looked for the cause?

Galen, Morgagni, with Budd, were amongst those who from an early time considered it to be an infectious disease.

Klenche and Villenin were the first to show that sputum or tissue from dead tubercular subjects inoculated into rabbits produced tuberculosis. Cohnheim, an ardent worker on this subject, confirmed these experiments. He inoculated tubercular material into the eyes of rabbits, and was thus able to set up a local tuberculosis which gradually but surely became general.

The result of these experiments suggested that the disease was probably due to a micro-organism, and many looked for it but failed to find it, until Koch by his classical experiments and new methods of staining was able to demonstrate to the Physiological Society at Berlin, in 1882, the bacillus which he argued was the *vera causa* of tuberculosis.

Cohnheim now knew, as he had long suspected, that tuberculosis was a specific disease, and he greeted the new discovery with these words:—

"I have seldom in all my life felt greater pleasure than at the reception of this news." Koch's arguments were so conclusive at that meeting that no one ever tried to combat his statement, and he concluded that memorable communication thus:—"We can with good reason say that the tubercle bacillus is not simply one cause of tuberculosis, but its sole cause, and that without tubercle bacilli you would have no tuberculosis."

Since Koch's discovery the bacillus has been cultivated outside the body, injected into rabbits and guinea pigs, producing the disease, and there discoverable in the animals so inoculated, conclusive proof that bacillus is the *vera causa* of tuberculosis, as Koch said.

Wherever these bacilli are found, no matter what animal they occur in, there the disease tuberculosis is present. They may differ a little in the different animals, but they are practically the same, though the bovine is more virulent than the human.

They are very minute organisms, about $\frac{1}{8000}$ to $\frac{1}{12000}$ of an inch in length, consisting of a delicate sheath with numerous ovoid granules. These are the spores which do not take up the staining matter, hence we get the spore bearing bacillus presenting a beaded appearance. For the most part they are

slightly bent or even curved. They may occur singly or in pairs, or even in close-packed masses. They are recognised easily by their size under the microscope, and also by their behaviour with certain staining re-agents. They are not discolourised by a 25% solution of sulphuric acid after staining with fuchsin. They multiply by fission as well as by spores, are non-motile, and found in greatest numbers just where the disease is spreading.

Besides being found in the tissues, they are abundant in the sputum of consumptive patients, as well as in the blood and urine.

They can be cultivated outside the body either on blood serum or glycerine agar—agar jelly at a temperature between 95° F. to 105° F. They form little colonies in 10 to 14 days, differing greatly in this respect from the bacillus of diphtheria, which will grow almost in as many hours.

A high or a low temperature will stop their growth, but the bacillus as well as the spores are very resistant against complete destruction. Though a certain amount of moisture is necessary for their growth, they can be dried without losing the power of infection.

Tubercular matter taken from the lungs of persons buried for years has been found virulent on inoculation. Cold does not seem to kill the bacillus, but growth ceases at a temperature of 82° F.

Heat at 250° F. destroys them, so will a temperature of 107·5° F. continued for several weeks.

The spores retain their virulence under conditions which are inimical to the bacillus, and the chief source of infection is by the spores floating about in the atmosphere.

What are then the modes of entrance by which the infecting bacillus may gain entrance into the body?

(1.) By the respiratory and (2) alimentary tract. (3.) By inoculation. (4.) Another mode of infection—hereditary transmission—will be considered as we go on. The channel of infection often determines the seat of the disease.

(1.) Aerial Infection through the Respiratory Tract.—In our ordinary surroundings of life the conditions necessary for the multiplication of the bacillus are never present, and we could only have tuberculosis by infection from one individual to another were it not for the fact already mentioned that the bacilli and their spores retain their vitality and virulence for a long time outside the body. In order that the virus may enter the lungs by the inspired air, the medium on which the micro-organisms develop must dry up and disintegrate into powder or dust. If it be remembered that the sputum of tubercular persons usually furnish the

richest supply of bacilli and their spores, and if it be borne in mind how carelessly this dangerous matter is treated, how it is scattered about the streets, the workrooms, the office floors, aye, and even the bedrooms, a source of infection will be found so great that none other need hardly be looked for.

One gets an idea of the virulence of this expectoration when we know that it retained its infective power six weeks, although kept moist and putrefaction had set in.

If the sputum was dried, on the other hand, it was found virulent by experiments on guinea pigs six months after being coughed up when kept from the action of the air.

Intermittent freezing and melting *does* not interfere with the power of transmitting the disease. It must not be supposed, however, that these tubercle bacilli are scattered about us without any choice or difference, but rather that they are principally found in narrow circumscribed regions, the centre of which is a tubercular person.

Ransome and Williams have been able to demonstrate the bacillus from air collected in the ventilating shaft of the Brompton Consumption Hospital, and inoculation experiments from the dust collected on the floor of this hospital have proved the infection to be present in the form of spores when the microscope had failed to show the bacillus.

Klein kept some guinea pigs in the ventilating shaft of the same hospital and they contracted the disease also.

Dr. George Cornet, in Germany, has found the bacillus in the dust of the street, but he points out a further source of infection from the handkerchief used by the consumptive. Here the sputum gets dried after repeated usage, and he has been able to get the bacilli from the bedclothes on which the handkerchief had lain during the night.

Strange to say, that although the walls in hospital wards where consumptives are kept have been found to be infected, other patients who may be suffering from some acute affection of lungs are still accommodated in many hospitals in the same wards as the consumptives.

Not only through the sputum may the air become infected, but also by the breath of the patient. When bacilli are given off by the breath they gradually sink, being heavier than the air, and as the temperature of the air is rarely sufficiently high to maintain their vitality active infection is not carried far in this way. There is nevertheless a great risk in the immediate inhaling of the breath of a consumptive, as might occur to anyone sleeping with an invalid.

(2.) Infection by the Alimentary Canal is perhaps the second most important mode of infection, and the disease in

this way may be communicated by means of milk or meat from diseased animals.

(*a*) Milk.—Doubt no longer exists about milk from tubercular cows being the means of conveying tuberculosis, particularly to infants and young children. Tubercular disease of the intestines and glands is almost peculiar to children, though we sometimes get it in adults as a secondary infection from swallowing their own sputum.

In such cases as these the gastric juice is weak and the bacilli are then particularly active. Infection may begin at the glands of the neck, or it may be a general infection or extend only into the glands of the abdomen.

Woodhead estimates that 79 per cent. of children dying of tubercular disease contract it in the mesenteric glands. Further, that it is most prevalent amongst children when milk forms the principal article of their diet.

Gerlach and Chauveau were the first to show that animals fed on the milk from tuberculous cows contracted the disease, Authorities are agreed that where there is a generalised tuberculosis, or where the udder is affected, the milk is highly infective, but they are not agreed as to whether the milk may be infective in cases of local tubercular disease where the udder is healthy.

Bang, Bollinger, and Hirschberger believe that the disease may be communicated by milk from tubercular cows even if the udder is not affected. These observers have been able to produce the disease by inoculation and by feeding experiments with milk from a tubercular cow with a healthy udder, and Woodhead and McFadjean were also able to produce positive results in a very small percentage of cases ; but while the negative results are the rule, nearly every observer has been able to get some positive evidence.

Klern * states "the feeding of calves with milk derived from an udder containing tubercular deposits produced tuberculosis in these calves, but milk coming from a healthy udder (though the cow had tubercles in the lungs) fails to produce tubercles."

The experimental researches for the recent Royal Commission seem to show that udder disease must be present before the milk is infective. Milk given or inoculated into rabbits and guinea pigs did not produce the disease when the udder was not affected, though the cow had advanced tuberculosis. Still, in view of the positive results obtained by different observers by the feeding of animals with milk from tubercular cows in which there was no udder disease, it would be much better

* Pathology of Infectious Diseases.

not to allow the milk of tubercular cows to be consumed, as there is an element of danger.

The presence or absence of the bacillus does not help us to say whether the milk is infective or not. Hirschberger has been able to produce the disease by intraperitoneal injection when no bacilli were present in the milk, and from this he infers the infection was present in the form of spores.

Woodhead and McFadjean examined 600 cows in Edinburgh and found 37 of them tubercular, but got the bacillus in the milk of only six of them.

And the experiments made for the recent Royal Commission show that in tubercular affections of the udder the bacillus was invariably present, and animals fed or inoculated with the milk contracted tuberculosis.

Dr. Sydney Martin's report is as follows:—"Five tuberculous cows with udder disease found *post mortem* to be of tuberculous nature; bacilli were found in milk of three. Fifteen (15) test animals fed and thirteen (13) inoculated with the milk of these three cows all acquired the disease. Of the other two cows the milk (in which no bacilli were found) from one produced tuberculosis in four out of ten test animals fed on it, and when inoculated in six other animals produced tuberculosis in all. The milk of the fifth cow did not produce tuberculosis in two animals to which it was given as food, but did produce tuberculosis in two other animals when it was inoculated."

If bacilli cannot be found in the milk then the only test is inoculation, and this means the employment of a skilled inspector.

(*b.*) Meat.—The danger of contracting tuberculosis from meat is not so great as the taking of milk from tuberculous cows, but it is nevertheless a source of infection if meat is not properly cooked.

When the disease is localised it is thought by some that there is little risk of eating the part of the carcase unaffected, but Professor McCall, of Glasgow, has shown that the bacilli, although not having their habitat in the blood, have been found there as well as in the marrow of bones. The authorities in Glasgow, acting on this, condemn the whole carcase. The Congress in Paris affirmed the necessity of these stringent measures, and many cities followed the example of Glasgow.

Klein is also of opinion that, inasmuch as the tubercular virus gets disseminated through the blood, any organ may at any time become infected with the virus—which is in transit. The organ need not contain any discernible tubercular deposit.

Woodhead was able to produce the disease in two rabbits by inoculating the raw juice from the rib muscles of a diseased cow where the tuberculous pleura had been stripped off by the butcher, but when he used the juice from the thigh muscles of the same cow he was not able to produce tuberculosis. He, therefore, shows that the parts in close proximity to the disease may be contaminated while the parts at a distance may not.

Bollinger and others found the juice expressed from the muscular tissue non-infective in 51 out of 58 carcases examined, and in these cases the lesions present were very extensive.

Dr. Martin's experiments show that in generalised tuberculosis the meat is dangerous, and in local tuberculosis the meat may be contaminated by the butcher's knife.

Still the Commissioners "are prepared to believe that if sufficient discrimination and care were exercised in taking meat from tuberculus cattle, a great deal of meat from them might without danger be consumed by the community." This recommendation is more in touch with the general belief that now exists—that the measures adopted by the Glasgow and Paris authorities are altogether too stringent.

In Germany it is not usual to condemn meat where there is only one organ affected if the animal is not emaciated, but if the animal is emaciated the flesh is held to be injurious.

3. Inoculation.—This is fortunately not a very common mode of infection. It has followed from a cut on the finger with a broken spittoon used by a phthisical patient. Medical men doing *post mortems*, butchers, and cooks have been infected, in the execution of their duties, in this way. It is said to have resulted in two cases from tatooing where the saliva of a phthisical patient was used. * It has occurred in Jews after the rite of circumcision being performed by an infected priest. In these inoculations there is generally nothing but a local tuberculosis set up, which ends in a suppuration, no permanent bad result following. Although rare in man, it is the general method of infection in experimenting with the lower animals.

4. Heredity.—The question whether tuberculosis can be transmitted from parent to child is one which authorities are divided upon. Many observers hold that the disease cannot be transmitted but only a predisposition, and heredity to such as Virchow and Frankel only means greater predisposition, but to others it means the actual transmission of the disease. It is, however, a fact that amongst some of the

* British Medical Journal, June 1st, 1895.

lower animals, as rabbits and guinea pigs, the disease may be transmitted, as was shown by the experiments of Berheim and others, and laid before the second Congress on Tuberculosis in Paris, 1891. It has seldom been found in calves, and rarely in new born infants.

While tuberculosis in some forms may be transmitted directly from parent to child, there is a very strong consensus of opinion that the form which affects the lungs is never so transmitted. But even in these cases, those who believe strongly in heredity will tell you that the germ has been in the system in a latent condition, while the tissues have been active, only asserting itself when the tissues have become more matured. But is the prevalence of consumption at this time not more likely to be due to the result of taking one's place in the world and being exposed to additional risks in the workroom, the office, etc.? It may then be taken for granted that "Consumption" is not hereditary, but only a predisposition; what that predisposition is we cannot yet say. Dr. Springthorpe, who has devoted a very large amount of study to this subject, speaking at the Medical Congress in Dunedin this year, defined it as "a bacterio-chemical question, affecting the strength of cells and serum in the struggle for existence with the invading microbe."

One thing seems certain, without this constitutional want of resistance the microbe is unable to invade and thrive in the tissues. This inherited tendency may be intensified, or it may be removed, but it will not, however intense in itself, cause the disease; the germ must be present. In the removing of this tendency lies the opportunity of preventive medicine, for there is usually ample time to correct this inherited tendency by careful attention to developmental requirements before "consumption" sets in.

Admitting then that heredity stands in rare cases as a channel of infection in some forms of tuberculosis, but in the majority of instances as only a predisposing cause, we now pass on to consider other circumstances which act as purely predisposing causes.

Predisposing Causes.—Certain conditions such as dampness of soil, impurity of atmosphere, are important factors in the ætiology of tuberculosis.

1. Dampness of Soil.—Dr. Buchanan and Sir John Simon have long since proved that "the drying of soil which has in most cases accompanied the laying of main sewers in the improved towns has led to the diminution more or less considerable of phthisis. They go on to quote certain cities where such improvements have been made and with what effect on the mortality of phthisis. They take 13 cities in

all, and the percentage of reduction from previous rates ranges from 49 in Salisbury to 47 in Ely, 43 in Rugby, 17 Croydon and Cardiff, to 11 in Merthyr, the lowest of the 13.

"It will be seen that the reduction of phthisis mortality where certain works have been executed is far too large and far too general to be regarded as an accidental coincidence. And the fact that in some of these cases the diminished fatality of phthisis is by far the largest amendment, if not the only one, which has taken place in the local health becomes extremely interesting and significant when the circumstances are remembered, that works of sewerage, by which the drying of the soil is effected, must always of necessity precede the accomplishment of other objects (house drainage, abolition of cesspits, etc.) on which the cessation of various other diseases is dependent."

Dr. Bowditch, working independently and without any knowledge of Dr. Buchanan's experiments, arrived at the same conclusions as regards the mortality in America.

The remarkable freedom from consumption in some of the drier countries, such as Egypt, Cape of Good Hope, as compared with moist Britain, leads one to the same conclusion.

Dr. Andrews, of Chicago, inquiring into the mortality of consumption, came to the conclusion that it is the greatest nearest the sea board, and diminishes as we pass inland. He found that in Massachusetts 25 per cent. of all deaths were due to phthisis; in New York, 20 per cent.; in Kansas, 8 per cent.; in Utah, 6 per cent.; in California, 14 per cent.; but here we are again nearing the Pacific.

Taken from North to South, the same observer found that in Michigan the death rate was 16 per cent.; in Indiana, 14 per cent.; in Tennessee, 12 per cent.; in Alabama, 6 per cent. We may therefore consider that dampness of soil and seaboard towns are favourable predisposing agents of tubercular disease. It would seem as if the bacilli were there in greatest numbers, and most deadly in effects. Localities with dry soils and uniform temperature are least affected.

2. Pollution of Atmosphere.—Nothing tends to predispose to tuberculosis so much as vitiated atmosphere. This is evidenced by the fact that we have consumption most common in large cities; not only so, but in the parts of them where overcrowding and bad ventilation is at a maximum the mortality is highest. If you compare the death rate in the army now with what it was 50 years ago you will see the effect of good and bad ventilation. From 1830 to 1846 the mean annual mortality from phthisis per 1,000 troops on home service was 7·86. It was greatest in the Foot Guards, 11·9; and lowest in the Household Cavalry, 6·28; and the only

reason that could be given for this great difference was that the barracks of the Foot Guards were badly ventilated. From 1858 to 1884 the average annual death rate (for 26 years) was 2·5 per 1,000 strength, and in the year 1888 it was 1·20, a great reduction from 7·86.

In Parkes' Hygiene we are told that in the third ventilated prison at Leopoldstadt, in Vienna, during the years 1843 to 1847, no fewer than 51 per 1,000 deaths were due to phthisis, while in the well-ventilated House of Correction in the same city, for years 1850 to 1854, the deaths from phthisis were 8 per 1,000.

Dr. Russell, of Glasgow, shows not only the effect of overcrowding on the total death rate, but also the great effect it has on the death rate from consumption. He divided the city into nine districts; in two districts there was an average of one and a half persons to each room, and in these districts the death rate was 16·7 per 1,000. In seven districts there was an average of two and a half persons to each room, and here the death rate was 30·7 per 1,000. Coming to lung disease, and principally phthisis, he shows the death rate in the first two districts to be 5·10; in the remaining 7 districts it was 11·38 (or more than double) per 1,000 living.

Wherever, then, we have overcrowding and bad ventilation, whether in our dwellings, workrooms, or office, we expect to find the future victims of consumption.

I have been speaking to you principally of foul atmosphere, arising from defective ventilation, due chiefly to the accumulation in the air of the air products of respiration, of exhalation from the human body, as well as the pollution of the atmosphere from the accumulations of filth, refuse, and other putrefying waste, but there are other impurities which tell on the mortality of phthisis besides these from organic vapours, namely, those from trades of different kinds. Just as there are many kinds of impurities, so we recognise many kinds of consumptions. We have the "knife grinder's" phthisis in Sheffield and Birmingham, then we have the "stonemason's" consumption, "weaver's" consumption, etc.

All trades which give rise to dust predispose, and particularly where metallic dust is floating about, to phthisis. Knife grinders, file makers, cutlers, and stonecutters are at the top of the list, while fishermen, agriculturists, and coal miners are the most exempt.

The inhaled dust in these cases simply acts in a mechanical manner by injuring the mucous membrane of the lungs, and thus favours the conditions for the growth of the bacillus should it be inhaled.

It need not be wondered at then that those who work at trades where the air is loaded with dust containing metallic particles should be more liable to phthisis than those who work in rooms where animal or vegetable dust is present.

3. Other Predisposing Causes.—Of other predisposing causes I need only mention improper food, in the case of infants especially, alcohol in excess, debilitating disease of any kind. In brief, it may be said that whatever reduces the vitality or resisting power of the body increases the susceptibility of the individual to tuberculosis.

Prevention of Tuberculosis.—How do we hope to prevent it?

1. By diminishing the sources of infection—through the air, milk, and meat—preventing the spread of the bacilli outside the body.
2. By increasing the resisting power of those who are most exposed to danger.

In carrying out the first our attention must be directed to sputum, because in this we have the most fruitful source of danger. The consumptive should be instructed not to spit anywhere except in a spittoon, in which there is a quantity of disinfectant, say a 10 per cent. carbolic acid solution. They should be strongly warned against spitting on carpets, floors of workrooms, offices, and streets.

Patients who do not care to carry a flask-shaped spittoon with them ought to use pieces of linen instead of handkerchiefs, which could be burned as soon as finished with.

Expectoration from all phthisical patients ought to be burned. Many people will tell you that the sputum in the street does not harm because the sunlight destroys the bacilli. I grant you the sun is one of the best natural disinfectants we possess, but the spores of the tubercular bacilli are very resistent, and they are not always exposed to the sun. Apart from the habit of expectorating on the streets being a filthy one, it is the greatest source of infection. What is required is that consumptives should be told of the danger they may be to others if they are careless in this matter.

Consumption does not spread through the virulence of its infecting agent, but rather because people are ignorant of its cause and mode of extension.

Hidden dangers are most to be dreaded, and it seems to me absolutely necessary that the people should be taught and able to appreciate the risk of this mode of infection.

From the working of Cornet the Germans have come to the conclusion that cleanliness is what is needed, and they have

adopted a system of public spittoons, and patients are requested not to spit anywhere else except in these receptacles.

The New York Board of Health has also a system of spittoons in their public buildings, railway stations, and other public institutions.

These spittoons are made of porcelain, and can be washed in boiling water and disinfected. Others are made portable of porcelain or glass and carried about by patients.

So much for the destroying of the expectoration.

But the respired air of the patient may also be dangerous by its immediate inhalation. We should avoid being too closely shut in with consumptives, hence it follows no one should sleep in the same room. Consumptives' rooms should always be well ventilated—such patients are not only more comfortable but their health is much better.

Should the patients die or be removed the room and everything in it ought to be disinfected. While cleaning operations are going on the floors and walls should be kept moist so as to prevent dust from flying about and with it the bacteria.

Curtains, bedding, and clothing should be boiled, blankets steamed, and all other furniture cleaned and disinfected.

Paper on the walls should be stripped off and burned and the walls washed with CHLORINATED LIME, the only disinfectant Ransome and Delepine have found to be effective. Ordinary fumigations by chlorine, euchlorine, and sulphurous acid are useless even in the hands of experienced fumigators.

In intestinal and other forms of tuberculosis all excretions ought to be disinfected with 10 per cent. carbolic acid solution, which is more effective for this purpose, according to Fischer, than corrosive sublimate solution (1 in 500) equal parts.

These are all minute details, but a strict adherence to * them has reduced the mortality in the Grand Duchy of Baden by no less than ·28 per 1,000 living. In 1882 the death rate there was 3·08. In 1887, it was after these precautions had been taken, 2·80 per 1,000 living. This seemingly small reduction, if applied to the United Kingdom, would mean an annual saving of life from consumption of 10,000 people.

At San Remo—a favourite residence for consumptives—all these precautions are carried out, and at the end of the season all public rooms and sleeping apartments are cleaned and disinfected.

*Sims Woodhead : Bacteria and their Products, p. 221.

It seems to be the time is fast approaching when tuberculosis will have to come under the notice of public health authorities.

Many argue that it must come under the Compulsory Notification Diseases Act and be treated as any other of the infectious diseases.

I confess this appeals very strongly to one, but there are many difficulties in the way of notification. For instance, we know that many consumptives are continually changing their residence, and often, in the hope of being cured, their medical attendant. Are we then to have a report from each medical attendant, and will the patients be required to notify any change of residence ?

In New York the Board of Health has formed certain regulations for its prevention. They sent a circular to all medical men stating that the Board had resolved—

1. To register all subjects suffering from tuberculosis so far as they could gather from the physicians in attendance.
2. To send inspectors, unless requested by the doctor attending not to do so, to instruct patients and their families how to guard against the spread of the disease.
3. To disinfect all premises either vacated by removal or by death of patients without any charge to owner.
4. To make bacteriological examinations for physicians and to report to physicians sending specimens free of charge.
5. To require authorities of public institutions to report all cases within seven days.

I am not aware that any other country has taken up this matter so strongly as the New York Board of Health, but in Victoria the Australian Health Society, at the instigation of Dr. Springthorpe, has issued printed slips, entitled " How to prevent the spread of consumption," to all medical men for distribution amongst their patients.

The recent Medical Congress at Dunedin passed a resolution recommending for the use of medical men in their routine treatment of phthisical patients the " Table of Advice " originally drawn up by the Australian Health Society. I have in a report to our Government advised that the Central Board of Health might get this Table of Advice printed and distribute it.

While I believe sanitary authorities could do much in the way of disinfecting houses and rooms where consumptives

die, I feel our best efforts will be of little avail unless we can get the assistance not only of the medical profession, but of the individual members of the community, and we can only hope for this aid by educating the people as to the cause and nature of this disease, and the measures which will prevent it. Let it be known further that it is not only preventable but a curable disease, and I feel confident that with increased knowledge of the nature of tuberculosis we will have a greater effort made by the community which will doubtless diminish its prevalence to a great extent.

Milk and Meat Infection.—It has been stated that about 5 per cent. of all milch cows are affected with tuberculosis, and it is further estimated that about 16 per cent. of all cattle slaughtered in England and Germany are tubercular. It is stated to be as prevalent in Australia as in England. I am glad to say that it does not exist in Tasmania, or if it does it is very rare.

It follows from what I have already told you that milk from tubercular cows must never be used, because there is risk even if the udder is not affected that the milk may be tainted. No tubercular cow should be allowed to remain in the dairy, because if the udder is not already affected it may become so at any time, and the extreme difficulty of recognising it in the earlier stages warrants the removal of the cow at once.

Boiling will get rid of any danger, and it is a good rule to boil all milk, as it will destroy the germs of other diseases as well as of tuberculosis.

But we must go further and prevent, if possible, the supply of such milk, and, of course, this means that all dairies must be registered and be inspected at regular intervals by a competent inspector.

The recommendations of the Royal Commission went further ; the Commissioners advise "wherever any udder disease the cow must be isolated at once, the milk being considered highly dangerous, until the inspector has proved the presence or absence of tuberculosis."

Meat is not such a dangerous mode of infection as contaminated milk. Nevertheless it is, as I have explained already, a source of danger, and calls for a rigid inspection of all meat before and after killing.

Dr. Martin's recommendations to the Royal Commission were that the "slaughtering and dressing of all animals ought to be done under skilled supervision, with the object of securing the removal and destruction of every part of the carcase that contained any tubercle whatever, and also the destruction of the whole carcase where the animal is found

to have advanced or general tuberculosis. He sees no objection to the sale of meat-substances from carcases which have shown only localised tuberculosis, and from which every particle of tubercle had been skilfully removed, provided always that in every subsequent process of preparing the meat for sale, due care be taken to guard the saleable portions from contamination by tuberculous matter."

"Total seizure," you see, is not advised as adopted in Glasgow and some other towns in the old country. The French Government, since the Congress, have decreed against it, Germany, and many other countries have considered it altogether too heroic a measure. That the bacilli may be found in the muscle and muscle juice, as well as in the blood of animals dying of a *generalised tuberculosis*, is proved by McCall, Bollinger, and others, but are they found in these structures in animals where there is only a *localised tuberculosis* ? Those who oppose "total seizure" say no, and further tell us that we must not forget that it is not tubercular material we are eating, but cooked meat, which has all the appearances of being healthy, derived from an animal which had merely a localised tuberculosis.

To sum up this: in all cases where the disease is general, or more than one organ affected, the whole carcase should be condemned ; where the tuberculosis is local, confined to one organ and the animal in good condition, the meat may be "passed," provided the organs are carefully removed and that the meat is not contaminated by the butcher's knife in dressing the animal.

All this goes to show the necessity of a proper inspection of animals before and after killing, and to do this we must insist upon all animals being slaughtered at public abattoirs. Any doubtful ones can be set aside to be tested with the tuberculin. The Intercolonial Medical Congress of 1896, in Dunedin, adopted the following resolution after a wide discussion on the subject of tuberculosis :—"That, recognising the serious extent to which tubercular disease prevails throughout Australasia, the fact that the disease is an infectious one, spreading through the medium of infected milk, meat, and air, this Congress begs respectfully to bring under the notice of the Governments of the different colonies the necessity which exists for the continuous and skilled inspection, veterinary as well as medical, of cattle and dairy stock, dairies, milk shops, abattoirs ; and for the proper disinfection of public spittoons, conveyances, buildings, etc., known or suspected to have become infected. The Congress also strongly urges the general use of tuberculin as a test for the presence of tubercular disease in dairy and other stock."

These measures will require to be aided by the thorough

cooking of all meat. It has been shown by Woodhead that boiling is the most effectual way of destroying germs in meat, next baking in the oven, and the least effectual way is roasting.

While we thus prevent its transmission from animals to man through our milk and meat supply, we must not forget that if we would get rid of this disease altogether we must go farther and see if we cannot exterminate it in cattle. Many believe that with the assistance of the State—and it is purely a matter for the State to deal with—that we can. How is it to be done? By the compulsory testing with tuberculin and slaughtering of every animal affected with tuberculosis, with or without compensation to the owners, as the State may think fit.

Tuberculin.—You remember a few years ago great excitement prevailed over what was supposed to be a cure for consumption, and how that excitement gave place to bitter disappointment.

It consisted in injecting a small quantity of a glycerine extract of pure cultivation of tubercular bacilli which Koch called tuberculin.

Now although tuberculin has not proved to be a curative agent, it is one of the most valuable diagnostic tests we have.

Any animal—whether in the dairy, abattoir, or amongst the herd—suspected can be injected, and if you get a characteristic fibrile reaction, you may consider tuberculosis is present in that animal's system. It has been claimed by Dr. Springthorpe that he has been able to diagnose tuberculosis in the human subject in this way before there were any conclusive physical signs or before there was any sputum.

Veterinarians are now agreed that 97 per cent. of cases which give a reaction with tuberculin will on *post mortem* examination prove to be tubercular.

This, then, is the first step—power of diagnosis in cattle—in this great undertaking. The Government of Denmark has set aside £25,000 to be used by Professor Bang for the purpose of exterminating tuberculosis, if possible, in the cattle of that country. Whether he will be able to do so or not remains to be seen, but his efforts will be watched with more than ordinary interest by all interested in this subject.

In Canada and Germany the cattle are subjected to this test, and the German Government has voted £10,000 to assist in compensating owners.

The Central Board of Health, Sydney, has also instituted an examination on similar lines, and pays 30s. compensation to all owners for every tubercular animal slaughtered.

In New Zealand the Acting Government Veterinary Surgeon was in the early part of this year using it freely, and so satisfied was Mr. Park with the results that he stated at the Congress in Dunedin "that he was perfectly satisfied that with the tuberculin test he would eradicate tuberculosis from all dairies."

During the early part of the present year the French Minister of Agriculture proposed to bring up a Bill for the compulsory testing and slaughtering of all tubercular animals and for the partial compensation for all animals killed. It was estimated that this would cost £200,000 the first year. In Tasmania it is doubtful if we have any tubercular cattle, and it is the duty of the authorities to see that none are introduced. Stock imported for breeding purposes should therefore be carefully examined and tested with tuberculin. Compared with the other colonies, our death rate from phthisis is very low, in fact the second lowest on the list. Might not this very low death rate be attributed to the fact that our cattle are free from tubercular disease?

We must now direct our attention to the second measure by which we hope to prevent tuberculosis, namely, *by increasing the resisting power of the constitution*, avoiding everything that tends to reduce the vitality and increase the susceptibility of the individual.

This must be partly undertaken by the individual and partly by the State,

What is then the Duty of the Individual?—I must be brief, because the care and upbringing of those who are predisposed to this disease is a subject altogether too large for a paper such as this.

What I have to say applies not only to those who may be predisposed by inheritance, but also to those who may acquire it.

The question of marriage concerns us here. It is one of the most important questions affecting our social state, and yet few questions are less frequently entertained professionally. It would be a wise rule that no person with active consumption should marry, but the sacrifice is, perhaps, too great to be expected, nevertheless they should be warned of the risk they run of leaving children behind them which will be depending, it may be, on the charity of friends either for their care or support.

Infancy.—No mother should nurse her infant if she is suffering from tuberculosis, as she may convey the infection directly or indirectly by kissing or through the breath. "It has been shown that tubercle bacilli may be present in the

mother's milk," * and the large number of cases of tuberculosis in the alimentary tract and glands in infants would seem to confirm this evidence.

The further nursing of the infants, the rules to be carried out in the management of the nursery, the food of the child, the exercise, the amount of mental work and the general hygiene of the youth are all matters to be attended to by the parents, acting under the advice and counsel of the family physician.

But for the young adult who goes out to the world to fight his own battle and accept fresh responsibilities to which he is yet unaccustomed, a few words of warning may not be out of place.

The choosing of a profession, trade, or other occupation is one of the most important as well as his first duty.

Certain occupations predispose more readily than others. I have already mentioned that fishermen and others employed in outdoor avocations are most free, while those who work in close atmospheres with dusty occupation are mostly attacked with it.

It is, therefore, of the greatest importance to see that the occupation is suited to the health of the individual, and it may be stated as a general rule that outdoor employment is better than office or sedentary indoor work, and that a country life is better than the close atmosphere of town.

It is impossible that everyone of us can either live in the country or have outdoor employment. Many are a good deal confined during office hours, but there are few who could not have outdoor exercise during some part of the day. What that exercise will be depends very much upon individual taste, but for perfect health it is necessary that every organ should have a share of activity. Nothing must be indulged in that interferes with the expansion of the lungs ; the very common exercise of bicycling is no doubt good, but the one great objection is the stooping position, which constricts the chest.

Walking, rowing, riding, outdoor games of different kinds are all very good, provided they are never carried to excess. It must never be carried to the point of fatigue, and taken when the weather permits. In the warm weather early morning or late afternoon are the best times, but during winter in the middle of the day we enjoy the sun most.

Clothing should be warm and light, equally distributed over the body ; woollen material is therefore the best for

* J. E. Squire, M.D.; The Hygienic Prevention of Consumption, p. 59.

underclothing. It should fit loosely and in no way interfere with the free movements of limbs or chest. Sudden change of temperature must be guarded against.

Diet should be plain and nutritious, with a large quantity of milk and fatty food if possible. The meals should be taken at regular intervals.

Alcohol should be avoided as a general rule, in fact it ought not to be taken unless under the direction of the physician. It must always be remembered that intemperance increases the predisposition by lowering the disease resisting power of the constitution.

Where possible, it is well to choose a healthy site for one's residence. Those who are predisposed should especially be careful that the house is built on a porous soil or is well drained. Damp clay, retentive soils are risky unless well drained.

The air round about should be pure and have free movement. It is also important that there should be plenty of sunlight, but how many people try in every possible way to block out the sun by verandahs overhung with creepers, trees, etc.?

The height above the sea level is of great importance. Not only do we get purer air the higher we get up, but the respirations become deeper in the high altitudes. Height above sea level has a marked effect upon the disease phthisis, as by the following death rates in Baden and Switzerland* :—

	Per 10,000 Deaths.		
Feet over Sea.	Baden.	Switzerland.	Medium.
Less than 1,600	1,040	860	950
1,600 to 2,700	830	730	780
2,700 to 3,200	750	390	570
Over 3,200	860	500	680

As already pointed out, a moist, damp atmosphere is a predisposing agent, and most seaboard towns are unsuitable. The Medical Congress, already mentioned, adopted the following resolution, which bears out this statement :—"That this Congress expresses the opinion that it is unwise and cruel to recommend advanced cases of phthisis to seek Australasia as a health resort ; that, whilst there are many places in the different colonies of great climatic value in the earlier and curable stages, the coastal regions generally are to be regarded as unsuitable for almost all stages.

A dry air, with plenty of sunshine, even if the temperature is low, seems most suited provided always the diurnal range of temperature is not too great.

* Mulhall Dictionary of Statistics.

Prevention by the State.—Although the individual may do much to prevent consumption, the results of our efforts depend very largely upon the sanitary conditions of our neighbours. It is, therefore, the duty of the State to see that no one is allowed to suffer from disregard of hygienic rules of those around him.

I have already pointed to the danger of dampness of soil, and what effect the laying of sewers and consequent draining of the subsoil water had upon the mortality of phthisis. It should be made absolutely compulsory to drain before a permit is given by any Health Board to build a dwelling.

The dwelling itself should receive the greatest attention. Although it may be too late to get existing houses remedied, precautions ought to be taken to prevent all new houses being constructed the plans of which are not first approved of by the Board of Health, who should see that all precautions are taken against dampness, that sufficient sunlight and ventilation are provided for by means of window space, height of ceilings, etc.

Dr. Ransome has shown in his paper on "Tubercular Infective Areas" in certain streets and courts, consisting of back to back houses, unfurnished with thorough ventilation, tubercular disease was much more common than in other parts of the town.

Overcrowding of houses, without proper space between, the regulating of the height of houses as well as the widths of streets, are matters which must be attended to by the public health bodies of the State. We want not only a plentiful supply of air, but also a pure supply; cleanliness then must be insisted upon, everything that pollutes the atmosphere must be removed.

Overcrowding of inmates in our lodging houses, our shops, workrooms, or factories must be prevented. There is nothing so inimical to the life of bacteria as sunlight, and no disinfectant so cheap. There should therefore be plenty of sunlight and good ventilation. Every workroom ought to be licensed to hold a certain number of workers, the number being determined by the space as well as by the means of ventilation. Under the Women and Children Employment Act we have power of inspection, but no provision is made to fix a minimum amount of cubic space for each person.

Such, then, are a few matters that might well be attended to with good effect. While the health authorities may do much, the individual must assist if we would overcome this deadly enemy.

I feel confident that once the danger of consumption being infectious is fully appreciated by the people we will have greater efforts made to prevent it.

In conclusion, it may seem to some of you that I have painted a very black picture of tuberculosis and its dangers. Let me say if I have increased your knowledge I have not increased the danger, and all I would ask of you is to make use of your greater knowledge. For, let me tell you, by way of comfort, that tuberculosis is not only a preventable but a curable disease, and the agents which prevent go far towards curing. In the light of recent discoveries in serotherapeutics, I am hopeful that some specific serum will yet be found, and that instead of tuberculosis exterminating the human race the human race will exterminate it. But it was not of the cure of tuberculosis that I came to speak, but rather its prevention, and might I not conclude in this, as in many other instances,

"PREVENTION IS BETTER THAN CURE."

DISCUSSION:

Dr. BRIGHT characterised the paper as a most able one. He agreed with almost everything Dr. Sprott had said, and did not know he had ever heard a paper calculated to be of better service to the community read at this society's rooms. He (the speaker) had been of opinion for 25 years that consumption was infectious. He had seen husbands taking it from wives, and wives from husbands, and he had always advised that a consumptive patient should occupy a separate room. Boiling the milk was most important. Dr. F. Swarbeck Hall strongly advised it in this city years ago. Much could be done by the efficient inspection of dairies and dairy cows. They had seen last summer what great dangers the health of the city was exposed to through bad and unwholesome milk being sold. The spread of infection by the sputum of diseased persons was a most serious thing. He believed very strongly that the disease was hereditary; that predisposition was not all that was communicated from parent to child. Tuberculosis was most common in aged milch cows. He moved a vote of thanks to Dr. Sprott, and hoped that the people would boil their milk, also that expectoration about the streets would be suppressed.

Dr. HARVEY seconded, and congratulated Dr. Sprott on the able way in which he had handled the subject. Another means of prevention was undoubtedly to be found in a reform in the manner of burying the dead. Spores of disease were often brought up by the earthworm.

Dr. CROSBY WALCH believed that the disease was not hereditary, but predisposition only was communicated from mother to child.

Mr. MAULT intimated that the Central Board of Health was seeking to obtain legislative power to inspect all dairies in the country sending milk into the city.

The CHIEF JUSTICE thought that if it be true that there was no tuberculosis in Tasmanian cattle, as Dr. Sprott had indicated, the colony must have a great advantage, and with the use of the tuberculine test in examining all stock brought to the colony for slaughter it might be kept out of our cattle and our meat.

The vote of thanks was passed with acclamation.

Dr. SPROTT, in replying, said it was generally conceded that consumption of the lungs was not hereditary, but tuberculosis was hereditary. So long as a person kept strong and in good health the bacilli of tuberculosis need not be feared. As to tuberculosis in stock in Tasmania, he had stated that he had not, so far, been able to find any.